APPENDICES

APPENDIX A: GLOSSARY

Glossary of Terms and Acronyms

Adaptation: This is the response to the changes that are occurring because of the excessive human-induced GHGs that have been collecting in the atmosphere for the past 100 years. While GHG reduction strategies are similar for most areas of the United States, the way that a community chooses to adapt to a changing climate is very specific for each region.

Baseline: The baseline serves as a reference point to assess changes in greenhouse gas emission from year to year. For purposes of calculating the baseline emissions, local governments generally estimate emissions from government operations and sources within the community.

Business-As-Usual (BAU): The BAU projection starts with the baseline year, a regulatory snapshot of the world at that time, and projects emissions into the future based on expected changes to population and economic activity.

Carbon Dioxide (CO2): This is the reference gas against which other greenhouse gases are measured and therefore has a Global Warming Potential of 1. It is naturally occurring and is also a primary by-product from combustion of fossil fuels and other industrial and agricultural processes.

Carbon Dioxide Equivalent (CO2e): This is a common unit for normalizing greenhouse gases with different levels of heat trapping potential. For carbon dioxide itself, emissions in tons of CO2 and tons of CO2e are the same, whereas for nitrous oxide and methane, stronger greenhouse gases, one ton of emissions is equal to 310 tons and 21 tons of CO2e respectively.

Carbon Sequestration: Carbon sequestration is the capture and long-term storage of atmospheric carbon dioxide through biological, chemical, or physical processes

Chlorofluorocarbons (CFCs): A family of inert, nontoxic, and easily liquefied chemicals used in refrigeration, air conditioning, packaging, insulation, or as solvents and aerosol propellants. Because CFCs are not destroyed in the lower atmosphere, they drift into the upper atmosphere, where their chlorine components destroy the ozone layer.

The California Environmental Quality Act (CEQA): This was a California statute passed in 1970, shortly after the United States federal government passed the National Environmental Policy Act (NEPA), to institute a statewide policy of environmental protection. CEQA does not directly regulate land uses, but instead requires state and local agencies within California to follow a protocol of analysis and public disclosure of environmental impacts of proposed projects and adopt all feasible measures to mitigate those significant impacts.

Climate: This is typically defined as the "average weather," or more rigorously, as the statistical description in terms of the average and variability of weather over a period of time ranging from months to thousands of years. These variables are most often temperature, precipitation, and wind. Climate can also refer to the global climate system.

Climate Action Plan: A description of the measures and actions that an organization will take to reduce greenhouse gas emissions and achieve an emissions reduction target. Most plans include a description of existing and future year emissions; a reduction target; a set of measures, including performance standards that will collectively achieve the target; and a mechanism to monitor the plan.

Climate Change: Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer). Climate change results from: 1) natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun; 2) natural processes within the climate system (e.g. changes in ocean circulation); and 3) human activities that change the atmosphere's composition (e.g. through burning fossil fuels) and the land surface (e.g. deforestation, reforestation, urbanization, desertification, etc.).

Co-Benefit: Multiple, ancillary benefits of a policy, program or intervention. Many climate change mitigation measures designed to reduce greenhouse gas emissions have other benefits such as energy and cost savings.

Corporate Average Fuel Economy (CAFE): The CAFE standards were originally established by Congress for new automobiles, and later for light trucks, in Title V of the Motor Vehicle Information and Cost Savings Act. Under CAFE, automobile manufacturers are required by law to produce vehicles with composite sales-weighted fuel efficiency, which cannot be lower than the CAFE standards in a given year. Standardized tests are used to rate the fuel economy of new vehicles.

Discount Rate: The choice of the discount rate for evaluating the net present value of these investments can be critical in determining whether or not to implement the associated mitigation efforts. By way of example, the Stern Review on the Economics of Climate Change utilizes a social discount rate of 1.4% for evaluating projects associated with climate change.

Energy Efficiency: This relates to a change in behavior in that the same function can be accomplished with less electricity. This usually requires newer equipment (such as televisions), different types of lighting (such as CFL bulbs) and other technology changes.

Energy Conservation: This is a typical practice using what you have more efficiently, such as shutting off the light or only using the dishwasher when it is full.

Emissions: The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Emissions Factor: A set of coefficients used to convert data from electricity, natural gas, fuel and waste to calculate GHG emissions. These emission factors are the ratio of emissions of a particular pollutant (e.g., carbon dioxide) to the quantity of the fuel used (e.g., kilograms of coal). For example, when burned, 1 ton of coal = 2.071 tons of CO2.

Forecast Year: Any future year in which predictions are made about emissions levels based on growth multipliers applied to the base year.

Global Warming: Global warming is an average increase in the temperature of the atmosphere near the Earth's surface and in the troposphere, which can contribute to changes in global climate patterns. Global warming can occur from a variety of causes, both natural and human induced. In common usage, "global warming" often refers to the warming that can occur as a result of increased emissions of greenhouse gases.

Global-warming Potential (GWP): This is a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide. A GWP is calculated over a specific time interval, commonly 20, 100 or 500 years. GWP is expressed as a factor of carbon dioxide (whose GWP is standardized to 1). For example, the 20 year GWP of methane is 72, which means that if the same mass of methane and carbon dioxide were introduced into the atmosphere, that methane will trap 72 times more heat than the carbon dioxide over the next 20 years.

Greenhouse Effect: The build-up of heat in the atmosphere (troposphere) near the Earth's surface due to infrared radiation from the sun being absorbed by water vapor, carbon dioxide, ozone, and several other gases. This heat is then re-radiated back toward the Earth's surface. As atmospheric concentrations of these greenhouse gases rise, the average temperature of the lower atmosphere gradually increases.

Greenhouse Gas: Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, but are not limited to, water vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (NO2), chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), ozone (O3), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6).

Green Streets: Urban transportation right-of-ways integrated with green techniques. Green streets provide a source control for a main contributor of stormwater runoff and pollutant load. In addition, green infrastructure approaches complement street facility upgrades, street aesthetic improvements, and urban tree canopy efforts that also make use of the right-of-way and allow it to achieve multiple goals and benefits. (EPA 2008)

Greywater: untreated wastewater that has not been contaminated by any toilet discharge or by any infectious, contaminated, or unhealthy bodily wastes, and does not present a threat from contamination by unhealthful processing, manufacturing, or operating wastes. Greywater includes but is not limited to wastewater from bathtubs, showers, bathroom washbasins, clothes washing machines, and laundry tubs, but does not include wastewater from kitchen sinks, dishwashers, or toilets.

Heating, Ventilation, and Air Conditioning (HVAC): These are mechanical systems that control the ambient environment (temperature, humidity, air flow and air filtering) of a building.

High Quality Transit Area: include smart growth areas, high employment areas, and transit-oriented development corridors. The following 14 Community Planning Areas were selected to prioritize the action and include one or more components of a High Quality Transit Area: Barrio Logan, Centre City, College Area, Kearny Mesa, Linda Vista, Midway-Pacific Highway, Mira Mesa, Mission Valley, Otay Mesa, Rancho Bernardo, San Ysidro, Southeastern San Diego, University and Uptown.

Hydrofluorocarbons (HFCs): Man-made compounds containing hydrogen, fluorine, and carbon that were developed as an alternative to ozone-depleting substances for industrial, commercial, and consumer products. HFCs do not have the potential to destroy stratospheric ozone, but they are still powerful greenhouse gases.

Intergovernmental Panel on Climate Change (IPCC): The IPCC was established jointly by the United Nations Environment Program and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Methane (CH4): A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 23 times that of carbon dioxide (CO2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills and sewage treatments, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion.

Measures: Any action taken to reduce GHG emissions.

Mitigation: This is putting in place enforceable plans, policies, and programs to reduce GHG emissions now in order to slow the rate of increase in the atmosphere. Successful mitigation at local, national and international levels will reduce the impacts of a changing climate for future generations. This is the legacy we leave.

Metric Ton (MT): Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 2205 lbs. or 1.1 short tons.

Mixed-Use: In a land-use planning context, a project that has at least three of the following amenities within a 1/4 mile radius: 1) residential development, 2) retail and/or commercial development, 3) park, and 4) open space. Mixed-use developments encourage walking and other non-auto modes of transport from residential to office/commercial locations. The project should minimize the need for external vehicle trips by including services and facilities for day care, banking/ATM, restaurants, vehicle refueling, and shopping.

Natural Gas: This is the typical fuel used in new power generating facilities in California. Underground deposits of gases consist of 50 to 90% methane and small amounts of heavier gaseous hydrocarbon compounds such as propane and butane.

Non-Potable Water: Water that is not suitable for drinking because it has not been treated to drinking water standards.

Perfluorocarbons (PFCs): Potent greenhouse gases that accumulate in the atmosphere and remain there for thousands of years. Aluminum production and semiconductor manufacture are the largest known man-made sources of perfluorocarbons.

Potable Water: Water that meets federal drinking water standards as well as state and local water quality standards so that it is safe for human consumption. Water treatment facilities that produce drinking water require a state permit.

Recycled Water: Treatment of wastewater beyond secondary treatment using tertiary filtration and chlorination. Water treated to this tertiary level is considered to be recycled water, which is suitable for many beneficial uses including irrigation or industrial processes. Recycled water meets treatment and reliability criteria established by Title 22, Chapter 4 of the California Code of Regulations.

Risk: Denotes the result of the interaction of physically defined hazards with the properties of the exposed systems - i.e., their sensitivity or social vulnerability. Risk can also be considered as the combination of an event, its likelihood and its consequences - i.e., risk equals the probability of climate hazard multiplied by a given system's vulnerability.

Resiliency: When referring to natural systems, the amount of change a system can undergo without changing state. When referring to human systems, the term "resiliency" can be considered as a synonym of adaptive capacity. This is determined by the degree to which the social system is capable of organizing itself to increase its capacity for learning from past disasters for better future protection and to improve risk reduction measures.
Sector: A term used to describe emission inventory source categories for greenhouse gases based on broad economic sectors.

Target Year: The year by which the emissions reduction target should be achieved.

Transit Oriented Development (TOD): A moderate- to high-density development located within 1/4 mile of a major transit stop, generally with a mix of residential, employment, and shopping opportunities. TOD encourages walking, bicycling, and transit use without excluding the automobile.

Urban Heat Island Effect: the significantly higher temperatures in a metropolitan area, relative to its surrounding rural areas, caused by waste heat generated by energy use and the modification of land by buildings and surface materials that retain heat.

Vehicles Miles Traveled (VMT): This unit measures the aggregate mileage traveled by all vehicles in a specific location. VMT is a key measure of street and highway use. Reducing VMT is often a major objective in efforts to reduce vehicular congestion and achieve air quality goals. The transportation sector is the top GHG emitter in California, contributing roughly 40% of all California emissions. Poor fuel efficiency and high vehicle miles traveled (VMT) are primary contributors to transportation sector GHG emissions. Meeting California's GHG emissions reduction goals requires reductions in both per-mile emissions (often measured in as a vehicle's miles per gallon performance) and vehicle miles traveled. Fuel efficiency has been addressed historically by the federal Corporate Average Fuel Economy (CAFE) standards, and California has passed its own legislation regulating GHG emissions from vehicles. The number of miles traveled has ramifications on insurance premiums, but there has not been and likely will not be any legislative action to curb VMT even though it is growing at a much faster rate than population or the economy.

Vulnerability: The degree to which systems affected by climate change are susceptible to and unable to cope with adverse impacts.

Unbundled Parking: Unpriced parking is often "bundled" with building costs, which means that a certain number of spaces are automatically included with building purchases or leases. Unbundling Parking means that parking is sold or rented separately. Occupants only pay for the parking spaces the actually need. This is more efficient and fair, since occupants save money when they reduce parking demand, are not forced to pay for parking they do not need, and can adjust their parking supply as their needs change.

Acronyms

AB - Assembly Bill
APCD – Air Pollution Control District (County of San Diego)
CACP - Clean Air and Climate Protection Software
CAP - Climate Action Plan
CAPPA - Climate and Air Pollution Planning Assistant
CARB - California Air Resources Board
CEC - California Energy Commission
CEQA - California Environmental Equality Act
CH4 - Methane
CO2 - Carbon dioxide
CO2e - Carbon dioxide equivalent
EPA - U.S. Environmental Protection Agency
GHG - Greenhouse gas
HFC - Hydrofluorocarbons
HVAC - Heating, ventilating, and air conditioning
IPCC - Intergovernmental Panel on Climate Change
KWh - Kilowatt-hours
LCFS - Low Carbon Fuel Standard
MMT - Million metric tons
MW - Megawatt
NO2 - Nitrous oxide
PPM - Parts per million
SANDAG – San Diego Association of Governments
SB - Senate Bill
TOD - Transit oriented development
USGBC - U.S. Green Building Council
VMT - Vehicle miles traveled

APPENDIX B: CITATIONS

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Photo Credits

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Executive Summary: Little Italy neighborhood

Chapter 1: Avenida Del Rio between Fashion V alley Mall and Camino De La Reina in Mission V alley, Construction at Balboa Park, and Liberty Station

Chapter 2: Green bike lane along Harbor Blvd, Car charging in Balboa Park, and Fed Ex Delivery Truck..

Chapter 4: Contractors installing photovoltaics

Chapter 5: Mission Valley flooded, Witch Creek Fire, Leaf, Green Street, and Flooded storm drain

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Chapter 3: Hillcrest neighborhood and City of San Diego Wastewater Treatment Plant

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Chapter 1: Balboa Park – Museum of Man

APPENDIX C: METHODOLOGY, FORECASTS, AND MEASURES

Appendix C.1: Method for Estimating GHG Reductions

Appendix C.1 provides information about the data, methods, and sources used to estimate the greenhouse gas reductions associated with the implementation measures included in the City of San Diego Climate Action Plan (CAP). The Energy Policy Initiatives Center (EPIC) estimated emissions reduction values for the federal, state, regional, and city-based actions selected by the City of San Diego. City-based actions are grouped into the five main strategies of the CAP: Energy and Water Efficient Buildings; Clean and Renewable Energy; Biking, Walking & Transit; Zero Waste Management; and, Climate Resiliency. The first section below provides common assumptions used across multiple measures, the following sections address the implementation measures at the state/federal level, regional level, and local actions included within each of the five main strategies.

GREENHOUSE GAS REDUCTIONS

Table 1 provides a summary of the CAP measures and their contribution to the overall reduction.

Table 1 Summary of Greenhouse Gas Emissions Reductions by Action

Federal & State Actions	2020	2035
Renewable Portfolio Standard	923,645	1,415,830
State Solar Programs	51,815	-
Pavley I/CAFE	1,316,326	2,356,009
Low-Carbon Fuel Standard	494,450	726,011.90
CARB Tire Pressure Program	30,670	26,201.00
CARB Heavy Duty Vehicle Aerodynamics	9,970	11,083

Regional Actions	2020	2035
SB 375	404,171	771,225

Local Actions	2020	2035
Strategy 1: Energy and Water Efficient Buildings		
1.1 Non-residential Water and Energy Conservation Ordinance (WECO)	65,162	55,036.98
1.2 Residential Water and Energy Conservation Ordinance	27,429	40,560
1.3 Energy Strategy for City Operations	13,371	5,699.52
1.4 New Water Billing Structure	14,170	11,037
1.5 Water Reduction from WECO (Res & Non-Res.)	9,640	12,556
1.6 Outdoor Water Conservation Ordinance	5,505	-
Strategy 2: Clean and Renewable Energy Resources		
2.1 Community Choice Aggregation	-	2,874,564.86
2.2 Net Zero Energy Buildings	8,862	-

Strateg 3: Biking, Walking, and Transit		
3.1 Mass Transit	112,643	235,149
3.2 Commuter Walking	1,095	2,194
3.3 Commuter Biking	32,178	74,562.66
3.4 Retiming Traffic Signals	899	1,063
3.5 Rondabouts	2,294	2,034.98
3.6 Municipal Zero Emissions Vehicles	12,144	21,859
3.7 Convert Municipal Waste Fleet to Natural Gas	2,018	10,144.19
3.8 Electric Vehicles Charging Infrastructure	133,354	781,390
Strategy 4: Zero Waste Managment		
4.1 Solid Waste Diversion and Landfill Gas Capture	115,855	219,639
4.2 Wastewater Treatment Emissions Capture	98,720	112,194
Strategy 5: Climate Resiliency		
5.1 Urban Tree Planting Program	43,839	73,064

Total GHG Reductions from Federal and State Actions	2,826,876	4,535,135
Total GHG Reductions from Regional Measures	404,171	771,225
Total GHG Reductions From Local	699,177	4,532,748
Total GHG Reductions	3,930,223	9,839,109

COMMON ASSUMPTIONS AND SOURCES

A set of common assumptions and sources was used to calculate emissions reductions for many of the implementation measures included in the CAP. The following section provides assumptions that were applied to measures related to electricity, natural gas, and transportation. Other measures have specific methods and data that are provided later in the document.

Common Background Data

Table 2 presents a summary of common data used to estimate both overall GHG emissions and the reductions estimates for each specific action.

Table 2 Common Data Sources for City of San Diego Climate Action Plan

Data Category	2010	2020	2035
Population	1,359,578	1,542,324	1,759,271
Vehicle Miles Traveled	13,745,004,004	15,114,486,656	18,255,806,585
Number of Vehicles	956,789	1,068,787	1,288,272
Licensed Drivers	918,577	1,046,005	1,211,598
Electricity Use (GWh)	9,042	9,950	11,632
Natural Gas Use (MM Therms)	396	397	430
Single-Family Housing Units	280,455	286,261	277,679
Multi-Family Housing Units	233,383	286,675	374,215
Water Consumption (Gallons)	70,283,508,998	79,730,603,631	90,945,701,929
Commercial Buliding Area (Square Feet)	234	286	362

Electric and Natural Gas-Related Measures

The following assumptions were used in calculating greenhouse gas reductions for measures related to electric and natural gas usage, including those in the Energy and Water Efficient Buildings and Clean and Renewable Energy Sources strategies.

- **Greenhouse Gas Intensity of Electricity** – The amount of greenhouse gases in each unit of electricity supplied by the utility or other electric service providers is an important factor in determining the emissions reductions of a range of measures included in the CAP. These calculations include a greenhouse gas intensity of electricity measured in pounds per megawatt-hour (lbs CO2e /MWh). Because this rate is dependent on many of the measures in the CAP, it is dynamically generated. For example, as the percentage of electricity provided by renewable energy sources increases the greenhouse gas intensity of electricity falls. Consequently, each reduction in energy use from energy efficiency improvements would yield a smaller greenhouse gas reduction. Similarly, as the total amount of energy is reduced by efficiency, the total reduction from increasing renewable energy supply from the utility declines. This calculation also includes the effects of increased electricity use for electric vehicles, which results in a reduction in emissions in the transportation sector and an increase in emissions in the electric sector. The 2010 starting value is 736 lbs CO2e/MWh. The emissions rate falls to 548 lbs CO2e/MWh in 2020 and then to zero in 2035 with 100% renewable supply.
- **Transmission Losses** – All electricity values include transmission losses to capture the total amount of generation and therefore emissions associated with consumption. Estimated average losses of 6% are included in the California Energy Commission's Energy Demand Forecast.

Common Sources for Electric and Natural Gas Measures

EPIC used the following source for the common assumptions listed above.

- Electric and Natural Gas Data: Kavalec, Chris, Nicholas Fugate, Bryan Alcorn, Mark Ciminelli, Asish Gautam, Kate Sullivan, and Malachi Weng-Gutierrez. 2013. California Energy Demand 2014-2024 Revised Forecast, Volume 1: Statewide Electricity Demand, End-User Natural Gas Demand, and Energy Efficiency. California Energy Commission, Electricity Supply Analysis Division. Publication Number: CEC-200-2013-004-SD-V1-REV. (hereinafter California Energy Demand Forecast 2014-2024)
- GHG Intensity of Electricity (lbs CO2e/MWh): This value is an estimate by the Energy Policy Initiatives Center estimate based on data from the Federal Energy Regulatory Commission Form 1 for San Diego Gas & Electric, U.S. Environmental Protection Agency Emissions and Generating Resource Integrated Database (eGRID) emissions factors, Sempra Energy 2012 Corporate Social Responsibility Report, and San Diego Gas & Electric.
- Transmission Losses: California Energy Demand 2014-2024 Revised Forecast.

Transportation

The following assumptions were used in calculating greenhouse gas reductions for measures related to transportation, including those in the Biking, Walking and Transit strategy.

- **Vehicle Miles Traveled** (VMT) – VMT values for 2010, 2020 and 2035 were obtained from California Air Resources Board's (CARB) Emissions Factor Model (EMFAC) 2011 model. Regional results were scaled to the City of San Diego on the basis of historical VMT ratios available from SANDAG. EMFAC 2011 is an Emissions Factors model used by regional transportation planning agencies in California to calculate air pollutants, including carbon emissions, from all on-road vehicles on all roads. EMFAC

2011 combines tested vehicle emission rate data with regional vehicle activity to provide greater accuracy for regional emissions. We used the EMFAC 2011 model to download the San Diego region's VMT and GHG emissions for the each vehicle class of the fleet. EMFAC 2011 provides GHG emissions with and without reductions from the Pavley 1 and LCFS standards. EMFAC 2011 emissions data does not provide reductions expected from SB375 targets for the MPOs.

- **Greenhouse Gas Intensity** – The greenhouse gas emissions intensity factor, grams of carbon dioxide equivalent per VMT (CO2e/VMT) for the region, with and without the Pavley I and Low Carbon Fuel Standard reductions area calculated from the EMFAC 2011 model. This factor was further adjusted to account for miles driven by electric vehicles. The effect of this forecasted (California Energy Commission) increased electric vehicles miles in 2020 and 2035 is to further reduce the carbon intensity of vehicle emissions but this is offset to some extent by an increase in the electricity sector emissions. It is assumed that the regional CO2e/VMT is representative of the City's vehicle emissions rate. This CO2e/VMT was used for the calculation of the GHG reductions from those city actions that affect VMT. Because the carbon content of the fuel mix decreases with time, for example due to the state's Low Carbon Fuel Standard, the carbon intensity per mile also decreases. Consequently, with time, any future measure that relates to VMT yields a proportionally smaller greenhouse gas reduction.
- **Fuel Reduction Measures** – Measures that depend on reduction in fuel consumption (traffic light retiming and roundabouts) were converted to CO2e reductions using an average factor (to represent gasoline and diesel) of 0.01 metric tons per gallon.

Common Sources for Transportation Measures

- Vehicle Miles Traveled: EMFAC 2011 is an EPA-approved model used by California to assess vehicular emissions, available at http://www.arb.ca.gov/emfac/ (hereinafter EMFAC 2011)
- Emissions per Mile: EMFAC 2011
- Carbon Content of Fuels: Carbon dioxide emissions from gasoline and diesel, at http://www.eia.gov/tools/faqs/faq.cfm?id=307&t=11

FEDERAL AND STATE ACTIONS

Federal and state measures are expected to reduce GHG emissions significantly over the timeframe of the CAP. This section provides a summary of the methods used to estimate the GHG reductions associated with the following actions:

- Renewable Portfolio Standard
- Solar Photovoltaics Policies
- Vehicle Efficiency Standards – Pavley I/CAFE
- Low-Carbon Fuel Standard
- CARB Tire Pressure Program
- CARB Heavy Duty Vehicle Aerodynamics Program
- SB 375

Renewable Portfolio Standard

Signed into law in 2011, the Renewable Portfolio Standard (RPS) requires California's electric service providers to procure 33% of electricity sales from renewable sources by 2020. Increasing the level of renewable energy supply lowers the greenhouse gas intensity of electricity (pounds of CO2e per megawatt-hour or lbsCO2e/MWh). To estimate the greenhouse gas reductions from this state policy, we assume that all renewable energy sources emit no greenhouse gases. We estimate the GHG reductions from RPS by taking the amount of electricity affected by the RPS in a given year and multiplying it by the difference in the GHG intensity for each year. To avoid double counting, we calculate the GHG reductions for energy efficiency and photovoltaics using the lbsCO2e/MWh value that already accounts for the effect of the RPS. We further assumed that SDG&E and other services providers will reach the 33% RPS target by 2020 and that the level of renewable electricity supply due to implementation of the RPS remains constant through 2035. Note that with enactment of AB 327, the California Public Utilities Commission has the authority to increase this percentage but no changes have occurred at the time of the final draft of the CAP. Table 3 summarizes the key assumptions used and results.

Table 3 Key Assumptions and Results for Renewable Portfolio Standard

Year	Percentage of Electric Sales Supplies by Renewable Sources	GHG Intensity of Electric Supply (lbs CO2e/MWh)	Total Sales Affected (GWh)	GHG Reduced (MT CO2e)
2020	33%	547.91	10,826	923,645
2035	33%	547.91	12,851	1,415,830

Sources

- Electric Sales for SDG&E Service Territory: California Energy Demand Forecast 2014-2024
- Energy Efficiency and Photovoltaics Effect on Sales: Estimate from Energy Policy Initiatives Center Greenhouse Gas Mitigation Planning Tool.
- RPS Requirements: See Senate Bill 2 at http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.pdf. See also Assembly Bill 327 at http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB327&search_keywords=
- GHG Intensity of Electric Supply (2010): Energy Policy Initiatives Center estimate based on Federal Energy Regulatory Commission Form 1 data, U.S. Environmental Protection Agency Emissions and Generating Resource Integrated Database (eGRID), Sempra Energy 2012 Corporate Social Responsibility Report, and San Diego Gas & Electric.

State Solar Programs

California has one of the most aggressive policies for promoting distributed solar photovoltaics, including programs and policies such as California Solar Initiative (and previously the Emerging Renewables Program), New Solar Homes Partnership, and Net Metering. California's residential rate structure – an inclining block structure that charges a higher marginal rate as consumption increases – also encourages solar photovoltaics. In addition to state measures, a federal tax credit also has provided a financial incentive for this technology. To determine the greenhouse gas reductions related to these programs and policies, we assume that total installed capacity through 2016 is directly attributable to these state and federal policies. We assumed 2016 because that is the year that the California Solar Initiative and federal tax credits are due to expire. Similar to the treatment of the state RPS law, we

assume that the capacity of solar photovoltaics attributable to state and federal policies in 2016 is held constant through 2035. Note that there are local measures that also promote photovoltaics such as net zero energy building policies. The total capacity and energy used of photovoltaics through 2016 used is based on the California Energy Commission forecasts of photovoltaics. No 2035 emissions reductions are included because it is assumed that 100% of electricity needs in 2035 are supplied from renewable sources. Table 4 summarized key assumptions used and results.

Table 4 Key Assumptions and Results for State Solar Programs

Year	Total Installed Photovoltaics Capacity (MW)	Capacity Factor	Percentage of Energy Produced at Peak	Total GHG Reductions (MT CO2e)
2020	119	20%	47%	51,815
2035	119	20%	47%	0

Sources

- Installed Photovoltaics Capacity: California Energy Commission California Energy Demand 2014-2024 Revised Forecast; personal communication with CEC Staff Asish Gautam (email 10-22-13).
- Capacity Factor and Contribution to Peak: California Energy Commission California Energy Demand 2014-2024 Revised Forecast; personal communication with CEC Staff Asish Gautam (email 10-22-13).

Increased Vehicle Efficiency Standards – Pavley I/CAFE

California's AB 1493 (2002, Pavley I) required manufacturers to achieve stringent tailpipe emissions standards for greenhouse gases equivalent to achieving a significant increase in fuel efficiency of cars and light-duty trucks. In May 2009, the federal Corporate Average Fuel Economy (CAFE) Standards were adjusted to conform to California's Pavley I equivalent. California then amended AB 1493 (Pavley I) to conform to the federal CAFE standard from 2012 to 2016, on condition that it receives a waiver to set its own vehicle standards after 2016 and enforce its standards for model years 2009 to 2011. CAFE mandates the sales-weighted average fuel economy in miles per gallon (mpg) for passenger cars and light-duty trucks in a manufacturer's fleet. New passenger vehicles must meet a sales weighted average of 39 mpg, light duty trucks a value of 30 mpg, resulting in a fleet average 34.5 mpg. This corresponds to a CO2e target of 250 grams per mile (g/mi) in 2016 from those vehicles.

The CAFE standards were tightened in 2012 for passenger vehicles by model year 2025. As explained in the Final Rule (49 CFR Parts 523, 531, 533, 536 and 537) for this change, the standards are tailpipe emissions standards for GHGs of 163 g/mi, which "would be equivalent to 54.5 mpg, if the entire fleet were to meet this CO2 level through tailpipe CO2 and fuel economy improvements. The agencies expect, however, that a portion of these improvements will be made through improvements in air conditioning leakage and through use of alternative refrigerants, which would not contribute to fuel economy." The method used assumes the 54.5 mpg fuel economy for new passenger vehicles starting in 2025.

To estimate the effect of these standards on GHG emissions, we use the EMFAC2011 emissions database to obtain the CO2e/VMT as well as CO2e/vehicle. For example, according to Pavley I, new car and light-duty truck tailpipe emissions must reach 205 and 332 grams/mile, respectively, starting in 2009 through 2016. Under the new national CAFE standards 2017-2025, new car and light duty truck tailpipe emissions must be 163 grams per mile by 2025. The GHG reduced is based on these per mile emissions multiplied by the portion of VMT related to cars and light duty trucks in any given year. We

hold these vehicle efficiency standards constant after 2025. Note that as the fleet turns over and new, more efficient vehicles enter the vehicle population, the emissions intensity of the total fleet (grams CO2e/mile) continues to drop. The CO2e per mile values are converted to total fleet CO2e/mile for use in evaluating other measures. Table 5 summarized the assumptions used and results.

Table 5 Key Assumptions and Results for Increased Vehicle Efficiency Standards

Year	Total Fleet CO2e Emissions Per Mile Driven (GramsCO2e/Mile)	Total Fleet CO2e Emissions Per Vechicle (GramsCO2e/Vehicle/Day)	Total Fleet VMT	Total Vehicle Population	Total GHG Reductions (MT CO2e)
2020	382	493	15,114,486,656	1,068,787	1,298,460
2035	347	447	18,255,806,585	1,288,272	2,356,009

Sources

- Fuel Economy Standards: Pavley I is found at http://www.arb.ca.gov/regact/grnhsgas/revfro.pdf. The Pavley I standards were adopted as federal CAFÉ standards for 2012-2016 models in "Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards"; Final Rule. 40 CFR Parts 85, 86, and 600; 49 CFR Parts 531, 533, 536, et al. The national standards for greenhouse gas emissions at the tailpipe for 2017-2025 are found in "Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards", 40 CFR Parts 85, 86 and 600,205
- Vehicle Miles Traveled: Regional VMT was downloaded from EMFAC 2011 emissions database for 2020 and 2035 at . We scaled regional to City of San Diego VMT from ratios based on a 2003 SANDAG study of VMT in regional cities.
- Grams per Mile for Fleet: Based on regulatory grams per miles for cars and light duty truck (see above, Fuel Economy Standards) scaled up to the whole fleet including heavy duty trucks.

Low Carbon Fuel Standard

California's Low-Carbon Fuel Standard (LCFS) requires that a regulated party (e.g., supplier of transportation fuel, including importers) reduce the carbon intensity per Mega Joule of its transportation fuel (gasoline and diesel) by 10% in 2020. To estimate the GHG emissions reductions associated with this state measure, it was assumed that the LCFS led to a 7.5% reduction in carbon intensity by 2020 and 10% in 2035. Electricity suppliers are considered regulated parties only if they elect to provide credit to fuel distributors. At this time, there are no monitoring reports of the status of use of electricity credits for the LCFS to indicate the magnitude of carbon intensity reduction that electric vehicles will play in 2020. The assumed delay in reaching the LCFS target in 2020 is due in part to litigation that has delayed implementation. Therefore, for CAP purposes, miles driven by electric vehicles are not considered a part of this standard. CAP also assumes no new low carbon fuel mandates in 2020. It is possible that the interaction of this standard with electric vehicles will have to be re-visited in the future. Table 6 summarizes the assumptions used and results.

Table 6 Key Assumptions and Results for Low-Carbon Fuel Standard

Year	Reduction in Carbon Intensity (grams CO2e/mile)	Emission Reduction Per Mile (grams CO2e/mile)	Reduction Per Vehicle (grams CO2e	GHG Reduced (MT CO2e)
2020	7.5%	31.7	41.0	494,450
2035	10%	38.6	49.7	726,012

Sources

- Low-Carbon Fuel Standard: California Air Resources Board. Information about the LCFS program is available at: http://www.arb.ca.gov/fuels/lcfs/lcfs.htm
- Grams per Mile for Fleet: Calculated from EMFAC2011

CARB Tire Pressure Program

The Tire Pressure Regulation went into effect in September 2010 and regulates tire pressure, which in turn improves fuel efficiency and reduces GHGs. In its Status of the Updated Scoping Plan 2010, CARB estimated that this requirement, which applies to all vehicles less than 10,000 pounds and is implemented by all automotive service providers, would reduce statewide emissions by 0.6 MMT CO2e in 2020. We scaled this value to the City of San Diego by VMT ratio to the State of California. This ratio is held constant between 2020 and 2035. Table 7 summarizes the assumptions used and results.

Table 7 Key Assumptions and Results for CARB Tire Pressure Program

Year	Statewide GHG Reductions (MT CO2e)	Fraction of CA VMT in San Diego	Total GHG Reductions (MT CO2e)
2020	0.6	9%	30,670
2035	0.6	9%	26,201

Sources

- Regulation To Reduce Greenhouse Gases from Vehicle Operating with Under Inflated Tires: Section 95550, sc10, c10, div 3, title 17, California Code of Regulations
- GHG Reductions from Tire Pressure Regulation: CARB Scoping Plan and Status of Scoping Plan Measures, page 4, at http://www.arb.ca.gov/cc/scopingplan/status_of_scoping_plan_measures.pdf
- Vehicle Miles Traveled in San Diego: Downloaded from EMFAC2011
- Vehicle Miles Traveled in State of California: 2010 California Public Road Data Statistical Information derived from the Highway Performance Monitoring System (HPMS) at http://www.dot.ca.gov/hq/tsip/hpms/hpmslibrary/hpmspdf/2010PRD.pdf

CARB Heavy Duty Vehicle Aerodynamics

The Heavy-Duty Vehicle Aerodynamics Program regulates use of devices to make trucks more aerodynamic, which in turn improves fuel efficiency and so reduces GHGs. In its Status of Update Scoping Plan Measures, CARB estimated that this regulation would reduce statewide emissions by 0.9 MMT CO2e in 2020. This value is held constant between 2020 and 2035. We scaled this value to the City of San Diego by VMT, assuming that miles driven by heavy duty trucks are distributed evenly throughout the state. Table 8 summarizes the assumptions used and results.

Table 8 Key Assumptions and Results for CARB Heavy-Duty Vehicle Aerodynamics

Year	Statewide GHG Reductions (MT CO2e)	Fraction of CA Heavy Duty Truck VMT in San Diego	Total GHG Reductions (MT CO2e)
2020	0.9	0.9%	9970.0
2035	0.9	1.0%	11083.0

Sources

- Heavy Duty Vehicle Aerodynamics Statewide GHG Reduction: CARB Scoping Plan 2008, Table 2, page 17. Revised estimate CARB 2011, page 5, at http://www.arb.ca.gov/cc/scopingplan/status_of_scoping_plan_measures.pdf
- Heavy Duty Truck VMT in San Diego Region: Obtained from EMFAC 2011
- Heavy Duty Truck Miles Traveled in State of California: 2010 California Public Road Data Statistical Information derived from the Highway Performance Monitoring System (HPMS)

REGIONAL ACTIONS

Many actions to reduce GHG emissions occur at the regional level, including transportation planning. The following action provides a summary of transportation actions that are implemented at the regional level, in this case San Diego Association of Governments.

SB 375

The City of San Diego will benefit from local measures that are part of the Sustainable Communities Strategy (SCS) adopted by SANDAG under California Senate Bill 375. Based on targets established under SB 375, the region is required to reduce per capita GHG emissions from personal miles driven (passenger cars and light duty trucks) to 7% in 2020 and 13% in 2035 compared with the value in 2005. The measures included in the SCS Strategy include measures based on incentives for telecommute and carpools, subsidies for vanpools and buspools, safe routes to schools to encourage walking to school, bottleneck relief projects such as increase in miles of freeway lanes to reduce fuel inefficient congestion, increase in miles of high occupancy vehicle lanes and freeway tolls, increase in the price of parking, bicycle lane increases and pedestrian zone improvements, smart growth and population density increases, and mass transit use increases.

To estimate the emissions reductions for the CAP, we scaled the expected per capita regional SB 375 GHG reduction amounts to the City level by population. However, mass transit, bicycle mode share, and pedestrian measures are not included within the SB 375 emissions reduction amount and are provided separately below. Table 9 summarizes the key assumptions used and results.

Table 9 Key Assumptions and Results for SB 375

Year	Per Capita CO2e Emissions Before SB 375 (MT CO2e/Capita)	Reduction in Per Capita CO2e Emissions (% below 2005 value)	CO2/Capita After SB 375	Total GHG Reductions (MT CO2e)
2020	4.88	7%	0.349	406,918
2035	5.21	13%	0.647	771,225

Sources

- Senate Bill 375: Available at http://www.leginfo.ca.gov/pub/07-08/bill/sen/sb_0351-0400/sb_375_bill_20080930_chaptered.pdf
- SANDAG Targets: See SANDAG Regional Transportation Plan 2050, Chapter 3, Sustainable Communities Strategy, available at: http://www.sandag.org/index.asp?projectid=349&fuseaction=projects.detail

- SANDAG SCS Actions: SANDAG Board Meeting, July 9, 2010, Item 3, SB 375 Implementation, available at: http://www.sandag.org/index.asp?committeeid=31&fuseaction=committees.detail -mSched

LOCAL ACTIONS

The Energy Policy Initiatives Center (EPIC) calculated emissions reduction values for a series of city-based actions leading to GHG emissions reductions from the five main strategies of the CAP: Energy and Water Efficient Buildings; Clean and Renewable Energy; Biking, Walking & Transit; Zero Waste Management; and, Climate Resiliency.

Strategy 1: Energy and Water Efficient Buildings

Electricity consumption accounts for about 25% of citywide greenhouse gas emissions, while natural gas accounts for about 17%. Because approximately 80% of electricity use and 90% of natural gas use is associated with buildings, many of the measures included in the City of San Diego CAP target building energy use. Similarly, there is a strong connection between water use and energy use. Energy is required to transport, treat, heat, and cool water, and it also requires water to produce electricity and transportation fuels. About 25% of California's combined electric and natural gas consumption is associated with water. While a significant amount is used to move water around the state, the vast majority of energy is used to heat water, typically in homes and businesses. Therefore, reducing use of either water or energy will positively impact both resources.

The City of San Diego CAP includes 5 measures to reduce emissions from the energy and water use. The following provides information about the data and methods used to calculate the related energy and greenhouse gas emissions reductions.

Goal: Reduce Non-Residential Energy Consumption

Action 1.1. Non-Residential Water and Energy Conservation Ordinance

To estimate the GHG reductions associated with this local action, we assume that non-residential building owners are required to increase energy efficiency at the time of sale. To determine the total amount of square footage affected by this local measure, we assumed that 5% of non-residential building space is sold each year. To eliminate to possibility of double counting, once a unit is affected by the policy it is removed from the building population. To estimate the level of energy reductions per project for non-residential buildings, we used findings from a Lawrence Berkeley National Laboratory (LBNL) study that found a median total energy reduction of about of 15 kBTU/ft2, or 18% of the average non-residential energy consumption in 2010 of about 82 kBTU/ft^2. Based on this average value, the CAP energy reduction calculations assumed a 15% energy reduction in 2020 and 2035. We assume that the average energy consumption is 16 kWh per square foot per year and 0.4 therms per square foot per year. Table 10 summarizes the key assumptions used and results.

Table 10 Key Assumptions and Results for Non-Residential WECO

Year	Total Area of Commercial Real Estate	Percentage of Total Area Sold Annually	Total Percentage of Area Affected	Total Area Affected (MM SqFt)
2020	286	5%	26%	75
2035	362	5%	53%	190

Year	Energy Reduction (per SqFt)	Electric Reduction (kWh/SqFt/Year)	Natural Gas Reduction (Therms)	Total GHG Reductions (MT CO2e)
2020	15%	2	0.1	65,162
2035	15%	2	0.1	55,037

Sources

- Average Energy Reduction per Project: Goldman, C., N. Hopper, J. Osborn, and T. Singer. Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data. LBNL-52320. January 2005. Available at http://eetd.lbl.gov/ea/emp/reports/52320.pdf.
- Annual Sales Rate: Colliers International
- Total Building Stock: Colliers International and California Energy Demand Forecast 2014-2024

Goal: Reduce Residential Energy Consumption

Action 1.2 Residential Water and Energy Conservation Ordinance

To estimate the GHG reductions associated with this local action, we assume that homeowners are required to increase energy efficiency at the time of receiving a permit for an addition or remodels and when they sell their residential unit. The number of residential units affected was estimated by using the rate of remodels and additions and sales of residential units. According to the City of San Diego Department of Development Services, approximately 0.5% of the existing stock of residential units in the City conducts a remodel or addition in an average year. According to the San Diego Association of Realtors, about 3% of the existing stock of residential units was sold in 2012-13 in the County of San Diego. We assumed that the rate was the same for residential units in the City of San Diego. To account for the fact that rented units would likely not be captured by this policy, we assumed that 48% of residential units – applied equally to multi- and single-family units – were owner occupied, according to the U.S. Census Bureau. To eliminate to possibility of double counting, we reduced the total quantity of owner-occupied units by the amount that already were affected by the policy. As a result, approximately 20% of single-family and multi-family owner-occupied homes would be affected by this local action in 2020 and approximately 50% of single-family owner-occupied homes in 2035. To determine the total energy and emissions reduction associated with this policy, we assumed that each participating unit reduced energy use by 15% below the average residential energy consumption value. Table 11 summarizes key assumptions and results.

Table 11 Key Assumptions and Results for Residential WECO

Year	Total Owner Occupied Single Family Units	Total Owner Occupied Multi Family Units	Percentage of Units Sold Annually	Percentage of SF Units Remodeled Annually	Percentage of MF Units Remodeled Annually	Total Percentage of SF & MF Homes Affected
2020	137,405	137,604	3.0%	0.5%	0.5%	19%
2035	133,286	179,623	3.0%	0.5%	0.5%	48%

Year	Total Homes Affected	Energy Reduction per Unit	Eletric Reduction per Unit (kWh/yr)	Natural Gas Reduction per Unit (Therms)	Total GHG Reductions (MT CO2e)
2020	52,699	15%	1,054	48	27,429
2035	149,492	15%	1,260	50	40,560

Sources

- Rate of Residential Permits for Remodels: Personal communication with Afsaneh Ahmadi, P.E., Chief Building Official/Deputy Director, City of San Diego / Development Services (email on 12-19-13)
- Sales of Residential Units in San Diego County: Comparative Sales - Existing Homes - December 2013, San Diego County. San Diego Association of Realtors.
- Rate of Owner-Occupied Units: U.S. Census
- Housing Units: San Diego Association of Governments
- Average Energy Consumption: California Energy Demand 2014-2024 Revised Forecast
- Average Energy Reduction per Unit: Based on data from the Energy Upgrade California program in SDG&E service territory.

Goal Reduce Municipal Energy Consumption

Action 1.3 Adopt a City Policy to Reduce Municipal Energy use by 15% in 2020 and 2035

To estimate the emissions reductions associated with this local action, we assume that the City adopts a policy to reduce overall energy use by 15% in 2020 and in 2035, commensurate with the target reductions for non-residential retrofits included in Action 1.1. We also assumed city energy consumption remained constant at 2010 levels because we assume that government infrastructure will not grow at the same rate as the rest of the economy. Also, the 15% reduction was applied equally to electric and gas consumption. Table 12 summarizes the key assumptions and results.

Table 12 Key Assumptions and Results for Municipal Energy Use Reduction

Year	Reduction in Overall Energy Consumption	Electricity Savings (GWh)	Natural Gas Savings (MM Therms)	GHG Reduced (MT CO2e)
2020	15%	30.9	1.1	13,371.1
2035	15%	30.9	1.1	5,699.5

Sources

- Average Energy Reduction per Project: Goldman, C., N. Hopper, J. Osborn, and T. Singer. Review of U.S. ESCO Industry Market Trends: An Empirical Analysis of Project Data. LBNL-52320. January 2005. Available at http://eetd.lbl.gov/ea/emp/reports/52320.pdf.
- City of San Diego Energy Consumption: City of San Diego

Goal: Reduce Water Consumption

The water use reduction goal for the City of San Diego according to SB X7 is to achieve a daily per capita of 142 gallons in 2020. The City target for 2035 is to achieve 100 gallons per capita per day (GPCD). We

apply three actions that result in per capita water consumption reduction from its *projected* per capita use in 2020 and 2035: a water rates measure already planned, the effect of a residential and non-residential WECOs and an outdoor water use ordinance.

We used the following assumptions to estimate the GHG reductions from reducing water use .

- **Energy Reduction** – The energy reduction from water use reduction is calculated on the basis of the most recent data available for the energy intensity for the five stages of water supply to the City. The five stages are: water supply and conveyance, water treatment, water distribution, end-use, and wastewater treatment. Water supply and conveyance is not included as the emissions from this are also not included in the City's GHG inventory or business-as-usual projection. The remaining stages are assumed to be within the geographical jurisdiction of the region and representative of the stages that water supplied to the City must go through. Each stage has a different intensity of energy (see below and Table 13).
- **Water Consumption Levels** –The reported 2010 per capita use in the City was 150 gallons. This includes residential, commercial, industrial, institutional and irrigational uses as well as system losses. The business-as-usual projection from the San Diego County Water Authority is 169 gallons in 2020. There is no projection for 2035 so we hold that value through 2035.
- **Energy Intensity of Water** – The energy intensities for water treatment and distribution were obtained from the most recently available CEC report (Navigant 2006) on energy use in Southern California. The energy intensity for wastewater treatment was calculated from data provided by the City's water treatment facilities. Table 13 provides the energy intensity factors used to estimate water-related GHG reductions in the CAP.

Table 13 Energy Intensity of Water for City of San Diego

Stage of Energy Use	Energy Intensity (kWh per Million Gallons)
Water Treatment	111
Water Distribution	1,272
Wastewater Treatment	997
End Use	3,900

- **Greenhouse Gas Intensity of Electricity** –The greenhouse gas intensity of electricity used to move water varies depending on the measures included in the plan. The 2010 GHG intensity value is 736 pounds per megawatt-hour.

Action 1.4 Adopt and Implement Proposition 218 for New Water Rates and Rate Structure

Proposition 218 reflects rate increases to be passed on to customers due to rate increases in the past few years from the San Diego County Water Authority to the City of San Diego. The rate increases apply to all SDCWA agencies, including the City of San Diego. Based on research, implementation of Proposition 218 would lead to water conservation. We assume an increase in water rates of 7.25% in 2014 compared with 2012 and an additional 7.5% increase in 2015 based on Proposition 218. We assume the same rate of increase occurs past 2020 towards 2035. The elasticity of water use due to rates was set at -0.2 based on a 2009 CEC study of residential water use in California. The elasticity was kept at -0.2 through 2035.

Electricity savings from rate increases are assumed to occur during water distribution, treatment, and 20% of end use energy use. Natural gas constitutes about 80% of end use energy use. Conservation of water due to increased rates therefore also leads to natural gas reductions and equivalent reductions in GHGs. Table 14 summarizes the key assumptions and results.

Table 14 Key Assumptions and Results for Updated Water Rate and Billing Structure

Year	Total BAU Water Consumption (Gallons/Year)	Total BAU Per Capita Consumption (Gallons/Day)	Per Capita Targets (Gallons/Day)	Cumulative Increase in Water Rates by Target Year	Reduction in Per Capita Water Consumption Due to Water Rate Structure (Gallons/Day)	GHG Reductions from Water Rate Structure (MT CO2e)
2020	95,138,255,940	169	141	15%	23	14,170
2035	108,520,631,635	169	100	30%	28	11,037

Sources

- Elasticity of Water Use: Price Impact on the Demand for Water and Energy in California Residences, Larry Dale, and K. Sydny Fujita et al., Lawrence Berkeley National Laboratory, August 2009 CEC-500-2009-032-F
- Water Use Projections: 2010 Urban Water Management Plan at http://www.sandiego.gov/water/pdf/uwmp2010.pdf
- Proposed Water Rates and Structure: Proposition 218 Notice, available at http://docs.sandiego.gov/councilcomm_agendas_attach/2013/NRC_130731_5b.pdf

Action 1.5 Adopt a Water and Energy Conservation Ordinance (WECO)

This action includes the GHG reduction from the WECO associated with water. It is separated from the energy efficiency effects to show the effect of water reductions alone. Reductions were based on reported water use decreases in the City of Berkeley due to their Commercial and Residential Conservation Ordinances of 22% decrease over 11 years, from 2000 to 2011, or 2% per year. We applied this 2% decrease per year to residential and commercial water use. We assume that the water reductions in the WECO are from indoor measures such as low-flow toilets and showers, similar to those required by the City of Berkeley. Table 15 summarizes key assumptions and results.

Table 15 Key Assumptions and Results for Water Reduction from WECO

Year	Total BAU Water Consumption (Gallons/Year)	Total BAU Per Capita Consumption (Gallons/Day)	Per Capita Targets (Gallons/Day)	Reduction in Indoor Residential Single Family Homes	Reduction in Per Capita Consumption Due to WECO (Gallons/Day)	GHG Reductions WECO (MT CO2e)
2020	95,138,255,940	169	141	22%	1.22	9,640
2035	108,520,631,635	169	100	52%	1.19	12,556

Sources

- Consumption Projections: Urban Water Management Plan 2010: Table 3-10 on total water use and projections; Table 3-12 for Base Daily per Capita Water Use 10-15 Year Ranges; Table 7, end use breakdown of energy intensity of water uses. Available at: http://www.sdcwa.org/uwmp
- Energy Content of Water: Navigant Consulting, Inc. 2006. *Refining Estimates of Water-Related* Energy Use in California: California Energy Commission, PIER Industrial/Agricultural/Water End Use Energy Efficiency Program. CEC-500-2006-118.

- Berkeley RECO: For typical WECO eligible examples, see RECO Compliance Guide, City of Berkeley at http://www.ci.berkeley.ca.us/reco/

Action 1.6 Implement Landscape Ordinance

This action is designed to address outdoor water use only. It is based on study by the Irvine Ranch Water District that there was a savings potential of over 43 gallons per household per day. This rate can be considered applicable to San Diego and was applied to outdoor water use to obtain water use reductions. Outdoor water constitutes the majority, or about 58% of total water use in San Diego. The water reductions were converted to electricity savings, and therefore GHG savings. When calculating energy savings from this ordinance, only electricity savings from distribution and treatment were included since outdoor water is not subject to wastewater treatment. There are no natural gas savings associated with outdoor water use. Table 16 summarizes key assumptions and results.

Table 16 Key Assumptions and Results for Landscape Ordinance

Year	Total BAU Water Consumption (Gallons/Year)	Total BAU Per Capita Consumption (Gallons/Day)	Per Capita Targets (Gallons/Day)	Reduction in Outdoor Consumption (Gallons/Day)	Reduction in Per Capita Consumption Due to Water Ordinance (Gallons/Day)	Reductions from Landscaping Ordinance (MT CO2e)
2020	95,138,255,940	169	141	43	20	5,393
2035	108,520,631,635	169	100	43	18	0

Sources

- Typical Water Use Reductions: Water Use in the California Residential Home, Consol, January 2010 available at http://www.cbia.org/go/cbia/?LinkServID=E242764F-88F9-4438-9992948EF86E49EA

Strategy 2: Clean and Renewable Energy Sources

The City of San Diego in the CAP has committed to pursuing the goal of supplying 100% of electricity needs in the City by renewable sources by 2035 by increasing the percentage of bulk electricity supplied to residents and businesses and distributed renewable energy.

Goal: 100% Renewable Electricity Supply Citywide

Action 2.1 Community Choice Aggregation Plan

To estimate the effect of this significant measure, the percentage of sales supplied from renewable sources was increased linearly from 33% in 2020, as required by the RPS, to 100% in 2035. The same assumptions used to calculate the effects of the RPS were used do estimate the emissions reductions that would result from 100% renewable electricity. Because of the interrelated nature of the actions, under a scenario in which 100% of electricity supplied in 2035 is emissions free, measures implemented in 2035 to reduce electricity yield no emissions reductions. However, non-emissions related changes are captured. For example, significant electricity reductions due to efficiency in 2035 will not result in any GHG reductions with 100% renewable supply, but they will reduce the base of electricity to be supplied, which in turn reduces the total amount of renewable electricity needed. Table 17 summarizes the key assumptions and results.

Table 17 Key Assumptions and Results for Community Choice Aggregation

Year	% Renewable Above RPS	GHG Intensity of Electricity After CCA (lbs CO2e/MWh)	GHG Reduced (MT CO2e)
2020	0%	548	0
2035	67%	0	2,874,565

Sources

- Electric Sales for SDG&E Service Territory: California Energy Demand Forecast 2014-2024
- Energy Efficiency and Photovoltaics Effect on Sales: Estimate from Energy Policy Initiatives Center Greenhouse Gas Mitigation Planning Tool.
- GHG Intensity of Electric Supply (2010): Energy Policy Initiatives Center estimate based on Federal Energy Regulatory Commission Form 1 data, U.S. Environmental Protection Agency Emissions and Generating Resource Integrated Database (eGRID), Sempra Energy 2012 Corporate Social Responsibility Report, and San Diego Gas & Electric.

Goal: Increase Installed Photovoltaics

State and federal policies to encourage investment in solar photovoltaics are assumed to phase out in the 2016-17 timeframe. Below is a local action to promote solar installations as state and federal programs phase out.

Action 2.2 Zero Net Energy Policy for New Construction (Solar Only)

To estimate the GHG reductions from this action, we assumed that the City of San Diego would adopt a Zero Net Energy Policy for residential homes by 2020 and for non-residential buildings by 2030, commensurate with the policy goals included in the California Energy Efficiency Strategic Plan. We assumed that 80% of all new buildings offset their entire electricity load with photovoltaics and that the total energy consumption was equivalent to the average residential or non-residential electricity consumption. Title 24 regulates new construction building standards but its requirements do not affect all energy loads, such as appliances and plug loads. Also the efficiency effects of the 2013 Title 24 2013 standards are included in the CEC forecasts for electricity and natural gas, so we don't include any of the potential energy reductions associated with the net energy zero policy. A capacity factor of 20% was used to determine the energy production of solar capacity. GHG emissions reductions from the residential portion of this policy are relatively low in 2020 because that is the first year the policy is in place. Also, there are no GHG reductions associated with this policy in 2035 because of the 100% renewable electricity action. However, the capacity of installed photovoltaics and the associated energy generation due to this policy are taken into account and affect other measures, such as the total amount of electricity needed for the 100% renewable energy action. Table 18 summarizes key assumptions and results.

Table 18 Key assumptions and results for Zero Net Energy

Zero Net Energy - Residential				
Year	Installed Capacity (MW)	Total ZNE Homes (SF + MF)	Average Electricity Offset Per Home (kWh)	GHG Reductions (MT CO2e)
2020	19	5,407	7,494	8,862
2035	345	84,365	8,963	0

Zero Net Energy - Non-Residential				
Year	Installed Capacity (MW)	Total ZNE Non-Residential Area (SqFt)	Average Electricity Offset Per Unit of Building Area (kWh/SqFt)	GHG Reductions (MT CO2e)
2035	223	30	16	0

Sources

- Housing Data: California Energy Demand Forecast 2014-2024
- Non-residential Building Area: California Energy Demand Forecast 2014-2024
- Energy Consumption: California Energy Demand Forecast 2014-2024

Strategy 3: Biking, Walking, and Transit

The transportation sector accounts for over 50% of all GHG emissions within the City of San Diego. The CAP includes eight transportation actions. The combined measures included in the San Diego Association of Government's Sustainable Communities Strategy to comply with the targets set under SB 375 (i.e., telecommute, carpool, vanpool, buspool, bottleneck Relief, HOV/HOT lanes). Mass transit, bicycle and walking commuters also play a role in avoiding personal vehicle use and reducing GHGs. How much reduction depends on the percentage mode share of commuters by transit, walking and bicycle. We restrict analysis to commuter mode shares, which will nonetheless have co-benefits for all users of alternative transportation. The GHG reduction amount is based on the projected number of employed persons in these high quality transit areas. The projected employment numbers for these areas were modeled by SANDAG for the City.

Goal: Increase Use of Mass Transit

Action 3.1 Implement Smart Growth Plans and City of Villages Strategy Mobility Element

According to the American Community Survey, about 4% of commuters used mass transit in 2010. Under the current Regional Transportation Plan (RTP) 2050, SANDAG expects this value to increase to about 7.8% in 2020 and about 10.1% in 2035 by increasing transit frequency, providing incentives, and adding new routes. Based on current transit mode share in 14 select High Quality Transit Areas, City staff, SANDAG staff and transportation experts believe that by prioritizing these community planning areas for transit improvements, it will be possible to achieve 12% commuter transit (peak period) mode share in 2020 and 25% commuter transit (peak period) mode share in 2035 cumulatively in these areas. High Quality Transit Areas include smart growth areas, high employment areas, and transit-oriented development corridors. The 14 areas selected are Barrio Logan, Centre City, College Area, Kearny Mesa, Linda Vista, Midway-Pacific Highway, Mira Mesa, Mission Valley, Otay Mesa, Rancho Bernardo, San

Ysidro, Southeastern San Diego, University and Uptown, which are part of the City of Villages Strategy. Table 19 summarizes key assumptions and results.

Table 19 Key Assumptions and Results for Mass Transit

Year	Mass Transit Commuter Mode Share in High Quality Transit Areas	Projected Labor Force in High Quality Transit Areas	Projected Number of Commuters using Mass Transit	VMT Avoided due to Mass Transit Use	GHG Reduction (MT CO2e)
2020	12%	504,178	60,501	288,037,900	109,895
2035	25%	569,416	142,354	677,726,041	235,149

Sources

- Employment Data: SANDAG model runs provided employment data for the High Quality Transit Areas for 2020 and 2035
- High Quality Transit Areas: The High Quality Transit Areas were selected by discussions with City staff, SANDAG staff and non-profit transportation experts.

Goal: Increase Commuter Walking in High Quality Transit Areas

Action 3.2 Implement Pedestrian Master Plan

The City of San Diego Pedestrian Plan of 2006 provides estimates for current mode share in the Community Planning Areas of the City. We assume an increase in pedestrian commuter mode share from less than 3% today (2010) to 4% in 2020 and 6.5% in 2035 in the selected High Quality Transit Areas. High Quality Transit Areas include smart growth areas, high employment areas, and transit-oriented development corridors. It is assumed that commuter walking will lead to an avoidance of 0.67 miles per day per commuter in 2020 and 2035. The emissions associated with a mile driven (CO2e/VMT) are determined by the assumptions included in other related VMT-dependent measures. The starting 2010 value was 500 grams of CO2e/VMT. Table 20 summarizes key assumptions and results.

Table 20 Key Assumptions and Results for Pedestrian Master Plan

Year	Roundtrip Commute Distance per Day (Miles)	Projected Labor Force in High Quality Transit Areas	Mode Share Goals in High Quality Transit Areas (%)	VMT Avoided Due to Bicycle Commuters	GHG Reduced (MT CO2e)
2020	0.67	504,178	3.3%	3,809,531	1,095
2035	0.67	569,416	6.5%	8,604,929	2,194

Sources

- Current Mode Shares: City of San Diego Pedestrian Master Plan 2006, Appendix D for current mode shares by Community Planning Area, at http://www.sandiego.gov/planning/programs/transportation/mobility/pedestrian.shtml

Goal: Increase Commuter Biking

Action 3.3 Implement Bicycle Master Plan Prioritizing High Quality Transit Areas

The City of San Diego Bicycle Master Plan of 2013 projects a 279% increase in bicycle commuters by 2022. Based on this and discussions with City staff and transportation experts, implementation of the Bicycle Master Plan could lead to increases in commuter bicycle mode share from less than 2% in 2010 to 6% in 2020 and 18% in 2035 in High Quality Transit Areas. High Quality Transit Areas include smart growth areas, high employment areas, and transit-oriented development corridors. The 14 areas selected were Barrio Logan, Centre City, College Area, Kearny Mesa, Linda Vista, Midway-Pacific Highway, Mira Mesa, Mission Valley, Otay Mesa, Rancho Bernardo, San Ysidro, Southeastern San Diego, University and Uptown, which are part of the City of Villages Strategy. Table 21 summarizes the key assumptions and results.

Table 21 Key Assumptions and Results for Bicycle Master Plan

Year	Roundtrip Commute Distance per Day (Miles)	Projected Labor Force in High Quality Transit Areas	Mode Share Goals in High Quality Transit Areas (%)	VMT Avoided Due to Bicycle Commuters	GHG Reduced (MT CO2e)
2020	8	504,178	8.0%	111,967,850	32,178
2035	8	569,416	18.5%	292,429,281	74,563

Sources

- Bicycle Commute Distance: SANDAG RTP 2050 on average bicycle commute distance in City of San Diego
- Current Bicycle Mode Shares: City of San Diego Bicycle Master Plan, July 2013 Final Draft, Prepared by Alta Planning and Design, available at http://www.sandiego.gov/planning/programs/transportation/mobility/bicycleplan.shtml. Table 5-12 for estimates of current mode shares in the City.

Goal: Reduce Vehicle Fuel Consumption

While the following transportation actions are not directly within a transit, bicycle or walking strategy, local actions to reduce vehicle fuel consumption in ways that do not reduce VMT are kept within the main strategy in order to have all local transportation actions within one overarching transportation strategy.

Action 3.4 Retiming Traffic Signals

Interconnecting previously uncoordinated signals in a centralized manner instead of independent unconnected lights have been shown to provide significant reductions in delays, congestion and emissions.[1] In 2001, SANDAG reported that out of the then existing 1430 signals, 486 traffic signals had been retimed since 1998 with plans to retime 320 more citywide. However, discussions with City traffic engineers indicated that it is reasonable today to re-time 15-20 signals in the City. Fuel savings per

[1] *See generally* the fuel reducing effects of the advanced traffic retiming system installed in Los Angeles, *available at*, http://ieeexplore.ieee.org/xplore/login.jsp?url=/stamp/stamp.jsp?arnumber=69967&isnumber=2453; **http://trafficinfo.lacity.org/**

intersection were assumed on the basis of studies by the insurance industry and a SANDAG study in traffic signal optimization. Table 22 summarizes key assumptions and results.

Table 22 Key Assumptions and Results for Traffic Signal Retiming

Year	Number of Signals Retimed	Fuel Saved Per Intersection (Gallons/Day)	Total Fuel Saved (Gallons/Year)	VMT Equivalent Mitigated (Miles/Year)	GHG Reduced (MT CO2e)
2020	15	7,835	42,896,625	2,297,623	899
2035	20	7,835	57,195,500	3,063,498	1,063

Sources

- Signal Re-timing Effects: SANDAG study on Traffic Signal Optimization Program, April 1994, page 4-17, Appendix C Exhibit 5.2
- Fuel Savings from Retiming: Continued Reliance on Traffic Signals: The Cost of Missed Opportunities to Improve Traffic Flow and Safety at Urban Intersections, Casey Bergh, Richard A. Retting, Edward Myers. September 2005. Insurance Institute for Highway Safety, at www.iihs.org.

Action 3.5 Roundabouts

Roundabouts can have a traffic flow smoothing effect leading to reduced fuel use by passenger vehicles. Discussions with City traffic engineers indicated that it is feasible to identify and install roundabouts in place of 15 intersections by 2020 and 20 by 2035. Based on research studies, we assumed that 20,000 gallons of gasoline fuel would be saved per intersection by improving traffic flow. Table 23 summarizes key assumptions and results.

Table 23 Key Assumptions and Results for Roundabouts

Year	Number of Roundabouts Installed	Fuel Saved Per Intersection (Gallons/Day)	Total Fuel Saved Annually (Gallons/Year)	Total VMT Mitigated (Miles/Year)	GHG Reduced (MT CO2e)
2020	15	20,000	109,500,000	5,865,024	2,294
2035	15	20,000	109,500,000	5,865,024	2,035

Sources

- Number of Roundabouts: Discussions with City staff on potential number of roundabouts to be installed
- Energy Reductions: Andras Varhelyi, the effects of small roundabouts on emissions and fuel consumption: a case study, Transportation Research Part D (2002) 65-71.
- Bird Rock Report: City of San Diego Manager's Report, Feb 4, 2004, Report No 04-028, for discussions of cost of Traffic Management Plan for the Bird Rock area of La Jolla.

Goal: Increase Municipal Zero Emissions Vehicles

Action 3.6 Achieve Zero Emissions Vehicles in Municipal Fleet

The City of San Diego maintains a fleet of more than 1,000 vehicles necessary to conduct operations. Converting the municipal passenger vehicle fleet gradually to EVs will reduce gasoline use, thus GHG emissions. The City of San Diego provided current use of gasoline consumption. We assumed that there would be no changes in 2020 and 2035 to this gasoline demand. The City's goals are to convert 50% of

gasoline and 90% of gasoline to zero emissions by 2035 from a 2010 baseline. Table 24 summarizes key assumptions and results.

Table 24 Key Assumptions and Results for Municipal Fleet Conversion to Zero Emissions Vehicles

Year	Assumed Gasoline Consumption (Gallons)	Assumed Disel Consumption (Gallons)	GHG From Gasoline (MT CO2e)	GHG From Disel (MT CO2e)	Gasoline Fleet VMT Converted to EVs	GHG Reduced From Switching Fraction of Gasoline Fleet to Evs (MT CO2e)
2020	2,598,220	2,259,625	24,288	24,923	50%	12,144
2035	2,598,220	2,259,625	24,288	24,923	90%	21,859

Sources

- Municipal Fleet Fuel Consumption: City of San Diego

Goal: Convert Municipal Waste Collection Trucks to Natural Gas

Action 3.7 Convert Municipal Waste Truck Fuels from Diesel to Natural Gas Starting 2018

The City of San Diego seeks to reduce emissions associated with hauling waste by converting from diesel fuel use to compressed natural gas. The conversion leads to reductions in GHGs overall but include emissions due to the natural gas. It was assumed that the energy content required by the waste fleet would remain the same through 2035. Table 25 summarizes key assumptions and results.

Table 25 Key Assumptions and Results for Municipal Waste Truck Conversion to Natural Gas

Year	Diesel Fuel Use Before Conversion (Gallons)	% of Fleet Convereted to NG	CO2 per pound for Diesel	Emissions Associated with Fleet NG Consumption (MT CO2e)	Net GHG Reduced (MT CO2e)
2020	1,000,000	20%	22.4	1.4	2,018
2035	1,000,000	100%	22.4	7.2	10,144

Sources

- Fuel Use: Diesel fuel use was provided by the City of San Diego, communication, November 2010.
- Timing of Fleet Conversion: City of San Diego. Conversion of the waste collection fleet will commence in 2018 with the goal to achieve complete conversion by 2035.
- Energy Content of Fuel – We assumed that the energy content of diesel remains constant in 2020 and 2035 at 129,500 British Thermal Units (BTU) per gallon of diesel. Annual Energy Outlook 2012, DOE/EIA-0383 June 2012, page 37

Goal: Increase Number of Electric Vehicles

Action 3.8 Implement an Electric-Vehicle Charging Network Siting Plan

To estimate the GHG reductions associated with this local action, we used the CEC 2014-2024 California Energy Demand Forecast to determine the projected electric consumption for residential and non-residential electric vehicles in the SDG&E service territory through 2024. Values between 2024 and 2035 were extrapolated from the CEC forecast. All values were scaled to the County of San Diego. Total annual electric consumption values were converted to vehicle miles traveled (VMT) using a standard electric vehicle efficiency rate of 0.34 kWh per mile. As a result, we assumed that electric vehicles accounted for an equivalent of about 3% of total passenger vehicle fleet VMT in 2020 and about 17% of

the total vehicle fleet in San Diego County in 2035. It was also assumed that the fraction of VMT in the entire County attributed to electric vehicles is the same as the fraction in the City of San Diego. Also, VMT values were converted to vehicles by assuming 10,000 miles per year. Even though the majority of charging occurs at home for personal vehicles, a network of public chargers is necessary to support a significant population of electric vehicles. Based on estimates by the Electric Power Research Institute it was assumed that the ratio of chargers to vehicles is 0.15, which would correspond to about 6,000 in 2020 and 30,000 in 2035, which would support a population of electric vehicles equivalent to 3% of total vehicles by 2020 and 17% by 2035. For comparison, Governor Brown's Executive Order B-16-2012, which seeks to increase zero-emissions vehicles to 1 million by 2020 and 1.5 million by 2025, would result in an electric vehicle population of about 3% of total vehicles in 2020 and 35% in 2035. To derive the GHG emissions reduction due to increased use of EVs, we assumed that an electric vehicle offset the entire emissions of an average non-electric vehicle. Increased electric consumption for electric vehicles were added in to the net electric consumption value, which is part of the business-as-usual projection. This approach accounts for the effects to both the electric and transportation sector. Note that the GHG intensity of electricity and the GHG intensity of a mile driven vary depending on the assumptions from other electricity- and miles-related actions. Table 26 summarizes key assumptions used and results.

Table 26 Key Assumptions Used to Calculate GHG Reductions from Electric Vehicles

Year	Projected Electricity Consumed by Electric Vehicles (GWh)	Projected Percentage of Total Fleet VMT Attributed to Electric Vehicles	Total EV VMT	EV Efficiency (kWh/mi)	Estimated Charging Infrastructure Needed (Public Charging Stations)	Total GHG Reductions from Evs (MT CO2e)
2020	111.91	3.0%	340,999,779	0.34	6,000	133,354
2035	684.50	17.0%	2,252,048,971	0.34	30,000	781,390

Sources

- Electric Consumption by Electric Vehicles: California Energy Commission California Energy Demand 2014-2024 Revised Forecast
- Electric Vehicle Efficiency Value: U.S Environmental Protection Agency
- Vehicle Miles Traveled: SANDAG Series 12/EMFAC 2012
- Charger to Vehicle Ratio: Bowermaster, D. (EPRI), *How much Electric Vehicle Charging is Needed?* California Plug-in Collaborative Meeting, August 2012. See also Bay Area Plug-In Electric Vehicle Readiness Plan: Background and Analysis, ICF International, December 2013.
- Governor Brown's Executive Order B-16-2012: See http://gov.ca.gov/news.php?id=17463

Strategy 4: Zero Waste management

Solid waste and wastewater management emissions account for about 5% of all GHG emissions within the City of San Diego. The CAP includes 2 measures to reduce emissions from waste: diverting solid waste and capturing landfill emissions, and capturing emissions from the wastewater treatment process.

Goal: Divert Waste and Capture Landfill Emissions

Action 4.1 Divert Waste from Landfills and Capture Landfill Gas

The CAP goals are to increase landfill gas capture to 80% in 2020 and 2035 to be in compliance with state landfill methane capture regulations. The CAP goal for waste diversion is to reach zero waste (90% diversion) disposed in 2040. Under AB 341, the State of California required jurisdictions to achieve a 50% diversion rate by 2000. AB 341 was amended in 2011 to read that it is state policy to achieve at least 75% diversion by 2010. The San Diego City Council approved the objectives of a Zero Waste Initiative in

2013 with the goal of reaching zero waste disposed in landfills in 2040. To accommodate this goal, it was assumed at 75% diversion would be achieved in 2020 and 85% in 2035. Table 27 summarizes key assumptions and results.

We calculated emissions reductions from this measure using the U.S. Community Protocol method for landfill gas emissions. We first calculated emissions reductions due to the increasing diversion of the generated waste from landfills from the current 52% to 75% in 2020, and then from 75% diversion to 85% diversion in 2035. We then applied the landfill gas capture rates of 80% in 2020 and 2035 to obtain the total emissions reductions from this measure. Table 27 below provides the effects of both diversion and capture. It also summarizes key assumptions and results.

Table 27 Key Assumptions for Waste Diversion and Landfill Gas Capture

Year	Total Waste Generated (Tons)	Total Emissions Before Any Diversion or Capture (MT CO2e)	Total Emissions after 52% Diversion (MT CO2e)	Diversion Rate	Total Emissions after Additional Diversion (MT CO2e)	Total Emissions After 55% Capture (MT CO2e)	Capture Rate	Total Emissions After Additional Capture (MT CO2e)
2010	2,493,702	474,462	227,742	52.0%	227,742	102,484	55%	102,484
2020	2,828,890	538,236	258,353	64.7%	189,997	85,499	80%	37,999
2035	3,226,808	613,945	294,694	83.7%	100,073	45,033	80%	20,015

Year	Emission Reductions Due to increasing Diversion rate from Additional Diversion (MT CO2e)	Emission Reductions Due to Capturing 80% of Non-Diverted Waste (MT CO2e)	Total Emission Reductions From Additional Diversion and Additional Capture (MT CO2e)
2010	0	0	0
2020	68,356	47,499	115,855
2035	194,621	25,018	219,639

Sources

- Current Landfill Waste Diversion: "How successful has San Diego been so far?" City of San Diego, at http://www.sandiego.gov/environmental-services/geninfo/faq/mandates.shtml#a4 which states that 52% diversion was achieved in 2004.
- For Content of Zero Waste Initiative: http://docs.sandiego.gov/councilcomm_agendas_attach/2013/NRC_131106_8.pdf
- CARB Methane Capture Regulation: Methane Emissions from Municipal Solid Waste Landfills, at http://www.arb.ca.gov/regact/2009/landfills09/landfillfinalfro.pdf
- Calculation Method: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, available at http://www.icleiusa.org/tools/ghg-protocol/community-protocol
- Emissions Factors: U.S. EPA Waste Reduction Model (WARM), available at http://epa.gov/epawaste/conserve/tools/warm/index.html

Goal: Increase Methane Capture from Wastewater Treatment

Action 4.2 Wastewater Emissions Capture

City of San Diego staff provided baseline and projected GHG emissions from wastewater management. The CAP goal is to achieve a capture rate of 98% in 2020 and 2035. The capture rate in 2010 was reported to be about 71%. Therefore the GHG emissions reduced arise from the difference in capture rates, of 27%. Table 28 summarizes key assumptions and results.

Table 28 Key Assumptions and Results for Wastewater Emissions Capture

Year	CH4 Emissions Factor (grams/person)	Forecast Total BAU CH4 Emissions (MT CO2e)	Forecast BAU N2O per Capita (kg)	Forecast Total BAU N2O Emissions (MT CO2e)	CH4 and N2O Capture Rate	GHG Reduced (MT CO2e)
2020	9,855	88,220	0.095	12,516	98%	98,720
2035	9,855	100,260	0.095	14,224	98%	112,194

Sources

- Wastewater Treatment Gas Capture Rate: A value of about 71% was calculated by EPIC and confirmed by the City.
- Methane Emissions Factor: The average methane emissions factor was obtained from California Air Resources Board, Communication May 2008.

Strategy 5: Climate Resiliency

Increasing urban tree cover contributes to the capture and storage (sequestration) of CO2.

Goal: Increase Urban Tree Coverage

Action 5.1 Develop and Implement an Urban Tree Planting Program

This action assumes an increase of hardwood tree cover as the type of urban tree that leads to sequestration during the growth and lifetime of the trees. The current urban tree coverage is estimated to be 6.4%, which converts to about 12,000 acres covered with trees in the City. There is a great diversity of trees per acre in the Community Planning Areas (CPAs). The greatest number of trees per acre, 3.99, is found in Greater Golden Hill while the lowest number is found in Tierrasanta. GIS analysis was used to obtain a developed area of about 187,500 acres. Based on research studies, typical hardwood trees absorb about 1.55 tons CO2 per acre. Table 29 summarizes key assumptions and results.

Table 29 Key Assumptions and Results for Urban Tree Planting Program

Year	% Urban Tree Canopy Cover	Corresponding Total Acres of Tree Cover (Acres)	CO2e Absorption per Acre (MT CO2e)	GHG Reduced (MT CO2e)
2020	15%	28,125	1.56	43,839
2035	25%	46,875	1.56	73,064

Sources

- Urban Forest Cover: Urban Ecosystem Analysis, San Diego, California, July 2003, Study by American Forests.org.
- Urban Forest Cover and Trees by CPA: City of San Diego, Urban Forest Management Plan: Background and Current Conditions, February 12, 2013
- For Hardwood Uptake Rates: Brown, S., T. Pearson, A. Dushku, J. Kadyzewski, and Y. Qi. 2004. *Baseline Greenhouse Gas Emissions and Removals for Forest, Range, and Agricultural Lands in California.* Winrock International, for the California Energy Commission, PIER Energy-Related Environmental Research. 500-04-069F. See also An Analysis of Regional Emissions and Strategies to

Achieve AB 32 Targets: Agriculture, Forestry and Land Use Report, Energy Policy Initiatives Center, 2008, available at http://catcher.sandiego.edu/items/epic/GHG-Agriculture1.pdf.pdf

Appendix C.2: Baseline and Emissions Projection Methods

EPIC estimated greenhouse gas emissions for the 2010 baseline value and a business-as-usual projection for the City of San Diego to estimate the level of emissions in 2020 and 2035 if no action were taken. The projection assumes that no new policies are adopted after 2010 and that there is no further activity on existing policies. This estimate becomes the level of emissions from which emissions from all CAP implementation measures are subtracted to determine if CAP targets are reached. There are a number of assumptions that are used to estimate future projections. The methods used to estimate GHG emissions for 2010 are consistent with the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. The following sections provide information on the methodology used to project emissions and the assumptions included in those calculations.

On Road Transportation

EMFAC 2011 was used to obtain regional VMT and GHG emissions for 2010, 2020 and 2035. This data was scaled to City VMT and GHGs by population ratio. It was also used to calculate a regional CO2e/VMT, which was assumed to represent CO2e/VMT for the City. The BAU projection for on-road transportation does not include emissions reductions due to the Pavely I/CAFE fuel economy standards or the Low Carbon Fuel Standard, or the miles driven by electric vehicles.

Sources

- Regional VMT and GHG Emissions: EMFAC 2011 is an EPA-approved model used by California to assess vehicular emissions, available at http://www.arb.ca.gov/emfac/.

Electricity

To estimate the GHG emissions from electricity use in 2010, we used consumption data for the City of San Diego provided by SDG&E. These values were multiplied by the greenhouse intensity value for electricity (lbs CO2e/MWh) used by the City of San Diego to calculate electric emissions in 2010. The value used was 736 lbs CO2e/MWh.

To project emissions from electricity use, we used California Energy Commission (CEC) forecasts for the San Diego Gas and Electric (SDG&E) service territory through 2024 (linear projections to 2035) to develop an average ratio between City of San Diego total consumption and SDG&E consumption for years 2009-2012. This ratio value was multiplied by the CEC forecast through 2024 and extended to 2035 to get an estimate of the City of SD consumption levels. The ratio value used (42%) is roughly equivalent to the ratio of franchise fee revenue from the City of San Diego to the overall SDG&E territory for years 2006 and 2007.

CEC Forecast Assumptions

The following provides a list of programs and policies that are included in the CEC's electricity forecast.[2]

[2] Table 21: Committed Building Codes and Appliance Standards Incorporated in CED 2013 Revised. Kavalec, Chris, Nicholas Fugate, Bryan Alcorn, Mark Ciminelli, Asish Gautam, Kate Sullivan, and Malachi Weng-Gutierrez. 2013. California Energy Demand 2014-2024 Revised Forecast, Volume 1: Statewide Electricity Demand, End-User Natural Gas Demand, and Energy

- Renewable Portfolio Standard – 11.9% of retail electricity sales in 2010
    - GHG Intensity of electricity 722 lbs/MWh
    - Assumes direct access providers have the same GHG intensity
- Utility Energy Efficiency Programs – electric savings from 2013-14 program cycle
- Residential Sector
    - 1975 HCD Building Standards 1992 Federal Appliance Standards
    - 1978 Title 24 Residential Building Standards 2002 Refrigerator Standards
    - 1983 Title 24 Residential Building Standards 2005 Title 24 Residential Building Standards
    - 1991 Title 24 Residential Building Standards
    - AB 1109 Lighting (Through Title 20)
    - 2010 Title 24 Residential Building Standards
    - 1976-82 Title 20 Appliance Standards
    - 1988 Federal Appliance Standards
    - 2011 Television Standards
    - 2011 Battery Charger Standards
    - 1990 Federal Appliance Standards
    - 2013 Title 24 Residential Building Standards
- Commercial Sector
    - 1978 Title 24 Nonresidential Building Standards
    - 2001 Title 24 Non-Residential Building Standards
    - 1978 Title 20 Equipment Standards 2004 Title 20 Equipment Standards
    - 1984 Title 24 Non-Residential Building Standards
    - 2005 Title 24 Non-Residential Building Standards
    - 1984 Title 20 Non-Res. Equipment Standards
    - 2010 Title 24 Non-Residential Building Standards
    - 1985-88 Title 24 Non-Residential Building AB 1109 Lighting (Through Title 20)
    - Standards 2011 Television Standards
    - 1992 Title 24 Non-Residential Building 2011 Battery Charger Standards
    - 1998 Title 24 Non-Residential Building Standards
    - 2013 Title 24 Non-Residential Building Standards

Sources

- City of San Diego Consumption: SDG&E
- SDG&E Service Territory Consumption: California Energy Demand Forecast 2014-2024
- GHG Intensity of Electric Supply (2010): Energy Policy Initiatives Center estimate based on Federal Energy Regulatory Commission Form 1 data, U.S. Environmental Protection Agency Emissions and Generating Resource Integrated Database (eGRID), Sempra Energy 2012 Corporate Social Responsibility Report, and San Diego Gas & Electric.

Natural Gas

To estimate the GHG emissions from natural gas use in 2010, we used consumption data for the City of San Diego provided by SDG&E. To project emissions from electricity use, we used California Energy Commission (CEC) forecasts for the San Diego Gas and Electric (SDG&E) service territory through 2024

Efficiency. California Energy Commission, Electricity Supply Analysis Division. Publication Number: CEC-200-2013-004-SD-V1-REV.

(linear projections to 2035) to develop an average ratio between City of San Diego total consumption and SDG&E consumption for years 2009-2012. This ratio value was multiplied by the CEC forecast through 2035 to get an estimate of the City of SD consumption levels. Note that the gas data used to calculate their inventory includes gas used for electric generation using cogeneration, therefore the ratio of City-provided consumption levels is higher than the ratio (about 75%) without natural gas for cogeneration (about 45%).

To estimate emissions from electricity projected consumption levels were multiplied by a conversion factor of 0.0053052 MMT CO2e/million therms of natural gas. This is equivalent to 5.31 metric tons of CO2e per therm.

Sources

- City of San Diego Consumption: SDG&E
- SDG&E Service Territory Consumption: California Energy Demand Forecast 2014-2024

Waste

Solid waste emissions were estimated using method SW.4 from the U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions. This method uses disposed waste in a given year (2010 for the baseline here), the characterization of waste, and emissions factors from the U.S. EPA Waste Reduction Model (WARM). Because a recent waste characterization study was not available for the City of San Diego or the region, it was assumed that the City's characterization was the same as the state's.

Wastewater emissions were calculated by the City based on EPIC's 2008 GHG Inventory methodology. This used a methane or nitrous oxide emissions factor per person developed by the California Air Resources Board for the region. The emissions factor for methane was 9,855 grams per capita, for nitrous oxide 95 grams per capita. The BAU for 2020 and 2035 includes the approximately 71% of wastewater treatment emissions captured today.

Emissions projections for both solid waste and wastewater were developed by taking the 2010 per capita rates and projecting them using population forecast.

Sources

- Disposed Waste: California Department of Resources Recycling and Recovery (CalRecycle) Disposal Reporting System (DRS)
- Calculation Method: U.S. Community Protocol for Accounting and Reporting of Greenhouse Gas Emissions, available at http://www.icleiusa.org/tools/ghg-protocol/community-protocol
- Emissions Factors: U.S. EPA Waste Reduction Model (WARM), available at http://epa.gov/epawaste/conserve/tools/warm/index.html
- Wastewater Volume: City of San Diego
- Characterization of Waste: California 2008 Statewide Waste Characterization Study, Table 7: Composition of California's Overall Disposed Waste Stream. CalRecycle, January 2009. Available at http://www.calrecycle.ca.gov/publications/Detail.aspx?PublicationID=1346

APPENDIX D: ADAPTATION RECOMMENDATIONS

Climate Adaptation Recommendations

Protecting Public Health and Safety Recommendations:

- Review current alert systems with health services and/or Centers for Disease Control and Prevention to identify effective improvements; work with health services to develop a communications campaign to educate the community about risks, precautions and symptoms; engage environmental health workers to identify and monitor known or potential breeding sites of vectors.
- Review current water treatment and monitoring programs; assess impact of rising temperatures on water quality and potential associated impacts to public health. Collaborate with wildfire authorities, health services and regional districts to identify shared vulnerabilities and responses; review current air quality warning system and revise if necessary; develop school education program and protocols with regard to wildfire affected air quality days.
- Consider potential water restrictions policy related to wildfire incidents.
- Review current heat wave response plans and revise if necessary; consult with health and emergency services to ensure alignment; involve event sector to maximize compliance
- Work with elderly care, children and social welfare services and health providers to create collaborative prevention awareness campaign. Coordinate and promote 'cool-safe' venues with proprietors and health services; review city policy for outdoor workers and prepare regionally aligned heat wave plan; promote early in the season to maximize community preparedness; require health services to record and report heat stress related illness and death to monitor impacts and results.
- Review current food preparation and storage requirements for outdoor events or temporary stalls and revise accordingly; include health issue advice in any relevant event permit applications to ensure awareness of issue; work with health providers to develop public awareness campaign.
- Review and revise, if necessary, public education programs, early warning systems and protective measures to help alleviate impacts.

Maintain Water Supply and Services Recommendations:

- In San Diego, 58% of water is used for residential purposes, which is expected to increase to approximately 66% by 2050. A significant amount of that water is used for landscaping. Therefore, water efficient landscaping is clearly a priority consideration for San Diego to adapt to climate change in this area and ensure sufficient water supply. A clear example is that a citywide residential reduction to 116 gallons per capita per day (gpcpd), which is a mere 11-gpcpd reduction from the 2010 average residential consumption in the City of San Diego, can eliminate 20,000 MT of CO2e per year due to reductions in energy for water treatment and distribution. Such a challenge requires the coordinated efforts of many stakeholders at government, industry and community levels. For the commercial and industrial sector, which consumes approximately a third of the supply, conservation and efficiency efforts should focus

on the largest users to gain the most significant results.

- Take immediate steps to reduce reliance on imports. Focus conservation programs on customer accounts (as identified by the Public Utilities Department) that represent the largest water savings potential. A communication program that encourages the efficient use of water and discourages water waste should accompany conservation programs. Price increases should consider social equity.

Protect and Maintain Urban Infrastructure and Community Services Recommendations:

- For critical assets at significant risk, implementing climate resilient asset management strategies early will ultimately decrease the risk of asset damage and failure that in turn reduces or minimizes the recovery costs resulting from an extreme event.
- Where response measures are considered important but not urgent, aligning the implementation of the measures with asset management, maintenance and renewal cycles means costs can be streamlined. While there may be additional costs for the resilience measures, these costs are minimized when incorporated with already budgeted replacement and renewal initiatives.
- It is also important that adaptation measures be planned in the context of the expected life span of the asset and the timing of the projected impacts of climate change. This allows resilience measures to be staged as climate becomes more extreme as well as builds in flexibility to allow variations to the response measures that reflects updated science, revised risk ratings or observed trends.
- Address potential subsidence and erosion affecting stability and safety of roads in drought conditions by aligning assessments with road maintenance schedules.
- Consider potential damage to, or destruction of, public and private infrastructure due to wildfires by identifying key service vulnerabilities and redundancy options.
- Consider potential power outages in heat waves due to demand exceeding supply and the impacts for water and wastewater infrastructure, building tenants and other critical infrastructure.
- Assess potential for blocked access in low-lying areas due to flash-flooding impacting residents, emergency services, local businesses, distribution networks, and through traffic causing mass delays. Consider seasonal drainage issues, additional pumping capacity and protocols in critical areas, highlight alternative routes and review emergency warning systems and traffic management.
- Address potential building and asset damage due to flash flooding in low-lying areas surpassing drainage capacity by reviewing flood preparedness programs, review drainage capacity and climate projections, promote flood preparedness in development approvals, and assess stormwater harvesting potential to alleviate drainage issues and water supply pressures
- Consider potential heat stress and damage to infrastructure in heat waves, including thresholds for warping of electricity network, bridge supports and train tracks, by relevant asset owners and authorities to identify risks and extreme event protocols.

Protect Environmental Health Recommendations:

- Working with local agencies region-wide to develop monitoring programs to address the problem and develop innovative solutions tailored to the emerging issues.
- Undertake climate change risk assessment and incorporate into City risk profile; review all processes and protocols to incorporate climate change considerations.
- Review, and if necessary revise, current invasive weed and pest management plans to address projected changed conditions; consider potential increased maintenance and resource requirements.
- Identify potential pollution channels and steps to prevent contamination; promote good waste practices upstream in the community.

Protect Open Space, Parks and Recreation Recommendations:

- Recreational alternatives or protection strategies can help to maintain the integrity of the park and recreation system; therefore, adequate training of City staff about adaptation measures is important.
- Providing public education and outreach can ensure that the community is aware of the safeguards and measures in place.

Coastal Management and Protection Recommendations:

- While protection measures can be somewhat gradual or progressive, ensuring that no unsuitable development is undertaken in known vulnerable areas should be a key priority to limit future damages and public risk.
- Estuaries and wetlands at risk of inundation threaten both the local species as well as the ecosystem services the area provides.
- Address potential inundation and erosion of soft shore, low-lying coastal residential and recreation areas that will damage assets and displace residents; consider potential coastal protection measures and associated impacts.
- Consider potential inundation and erosion of soft shore low-lying coastal business and tourism areas and evaluate resulting economic losses; consider potential coastal protection measures and associated impacts; work with local businesses to identify opportunities for retreat; develop progressive shift strategy to alleviate future damage and ensure preservation of future community identity and appeal.
- Consider potential inundation and erosion of soft shore, low-lying coastal estuaries and wetland areas which will endanger local biodiversity and ecosystem services by working with relevant agencies to establish assessment and protection principles and protocols; ensure consideration of ecosystem services in assessing vulnerability and values.
- Identify key issues and vulnerable species in the short, medium and long term; collaborate with other districts sharing resources and maximizing effective opportunities for species and habitat protection.

- Identify vulnerable properties and work to ensure collaborative solutions and minimize future liability; identify range of potential response measures that together create a planned and progressive solution, minimizing social and economic damages.

Urban Forest Management and Local Food Production Recommendations:

- Develop a City-wide GHG Emissions Sequestration Report that provides land use practices that have successfully sequestered GHG by 2020.
- Develop a City Foodshed Development Plan by 2020 to expand local food production and distribution. Pursue policy and land development code amendments as needed. This Plan will support food system planning that increases food system security, strengthens food system infrastructure, links local producers to local markets, creates jobs, and re-circulates food dollars in the local economy. Incentivize the local production and distribution of food by way of municipal purchasing policies.
- Monitor effectiveness of code and process amendments designed to facilitate the establishment and operations of community gardens, while minimizing conflicts. Staff to prepare status report for the general public by 2025.

Building and Occupant Readiness Recommendations:

- Create connected communities - Community stakeholders from all sectors such as neighborhood watch, homeowner associations, community groups, businesses, non-profits, government, schools, faith based groups, medical emergency management, collectively forming relationships built on the foundation of communication and trust.
- Develop resiliency guidelines within the current project review and permitting process. Developer and design teams can utilize climate change resiliency guidelines and checklists to analyze a proposed project's impacts on the surrounding environment and that projects ability to respond to the changing climate impacts including the survivability, integrity and safety of the project and its inhabitants.
- Ensure passive survivability of new construction and essential service facilities. Originally developed as a concept following post-hurricane Katrina Gulf Coast reconstruction, the term passive survivability emerged as an umbrella concept to convey the idea of buildings that maintain livable conditions and functionality in the event of extended power outages, interruptions of fuel supply, or loss of water and sewer services. Many architectural and engineering solutions will support Climate Mitigation strategies as well, these include, but are not limited to: high-performance building envelop, reduce heating and cooling loads, natural ventilation, natural day lighting, photovoltaics and solar thermal heating.
- Relocate and protect building systems within structures. The ground floors of many existing buildings in our coastal community are at risk from flooding. Essential building equipment is often located on these lower floors. Consider vulnerable building elements – such as electrical services, fire protection systems, compressed gas or hazardous material tanks, and vent piping – must be located above the design flood elevation in new and renovated buildings in flood zones.

- Pre-approve emergency inspectors. Development Services Department has procedures to mobilize large numbers of public and private sector inspectors trained for post-disaster building assessments. There are opportunities to speed implementation and enhance capabilities by formalizing this program.
- Store water on site; consider using rainwater to maintain a cistern. Provide water storage to serve the building during an extended loss of water. Ideally, store this water high in the building, such as on the rooftop, to facilitate gravity delivery. In cohousing communities and planned neighborhoods, shared water systems can be developed with gravity-feed to dwellings. Cisterns can be fed with rainwater and used during normal building operation for landscape irrigation and, depending on local permitting, for toilet flushing—as long as an adequate reservoir is maintained for emergency use. Such cisterns can also serve fire suppression needs where risk of fire is present.

Community Education, Knowledge and Collaboration Recommendations:

- Form an inter-departmental "resilience team" with key players from relevant City departments that meets regularly to build internal knowledge about the projected changes the City will face as well as identify relevant internal decisions, policies and programs the City already has in place that can respond to these changes.
- Identify community champions (either individuals or private organizations) who can help the City provide public education and outreach to private organizations, community groups and residents about the projected local climate impacts and how they can work with the City to build their resilience.
- Actively participate in projects with other local governments to address shared risks and build resilience, such as those projects of the Climate Collaborative – San Diego Region
- Educate business on resiliency plans so that they can be proactive in making arrangements and connections to further their economic growth and reach out to anyone in the community that may be in need. Can the business provide training and/or jobs to unemployed community members to increase the economic vitality of the entire community? Make a plan and make a long-term difference! Decreasing vulnerability decreases recovery time.
- Educate young students in elementary, middle and high school and how they can prepare themselves, their families and their homes to be resilient. Education of climate change and sustainability, such as this, at a young age will also make students more likely to be prepared as adults.

APPENDIX E:
Climate Action Plan Compliance Checklist for New Construction for CEQA Tiering

Climate Action Plan Compliance Checklist Forthcoming